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Glovebox Ergonomics Basics for Ergonomists Course #50606

Before We Begin

Let's talk about…

Webex Etiquette

Roster

Time Requirements

Breaks

Phones

Design Review

Course Survey

Glovebox Ergonomic Basics
Training Objectives

Upon completion of this course participants will:

- Have an understanding of common topics and terms associated with glovebox basics.
- Be able to identify common types of musculoskeletal disorders
- Be able to identify high risk activities associated with glovebox activities
- Be able to demonstrate knowledge of glovebox ergonomic controls and best practices
- Be able to demonstrate knowledge of glovebox ergonomic design / usage guidance and best practices
- Be able to demonstrate knowledge of preventable exercises for glovebox ergonomic injuries

Glovebox (GB) Training Topics

GLOVEBOXES (GB) – WHAT, WHO, WHERE, HOW?

ERGO EVALUATIONS FOR GB

ERGO HAZARDS WITH GB

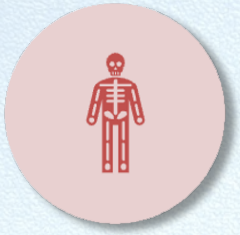
COMMON ERGO INJURIES

GB ERGO GUIDANCE

ERGO EVAL PRACTICE

HOMEWORK?!

= Info for GB workers



What is a Glovebox (GB)?

- Containment units used to protect workers from material or, material from workers
  - Atmosphere inside
    - Positive or negative pressured
    - Filled with different gases
  - Can be single units or multiple units linked to a filtration system
  - Houses various equipment
  - Houses various chemicals and materials

GB not at LANL

- Pharmaceutical

Space

NICU Incubator

Where are GBs at LANL?

- Many places… under the following management:
  - ALDWP
  - ALDW
  - ALDCELS
  - ALDPS
  - ALDCP (builds)
  - ALDFO (manages)
  - Etc.

Bradbury Science Museum

GB at LANL

- Chemistry / Material Science – TA 03, TA 48, TA 35, etc.

WETF – TA 16

Pu/Am/U/Other high radiation emitting material – TA 55

Spot the differences!

1

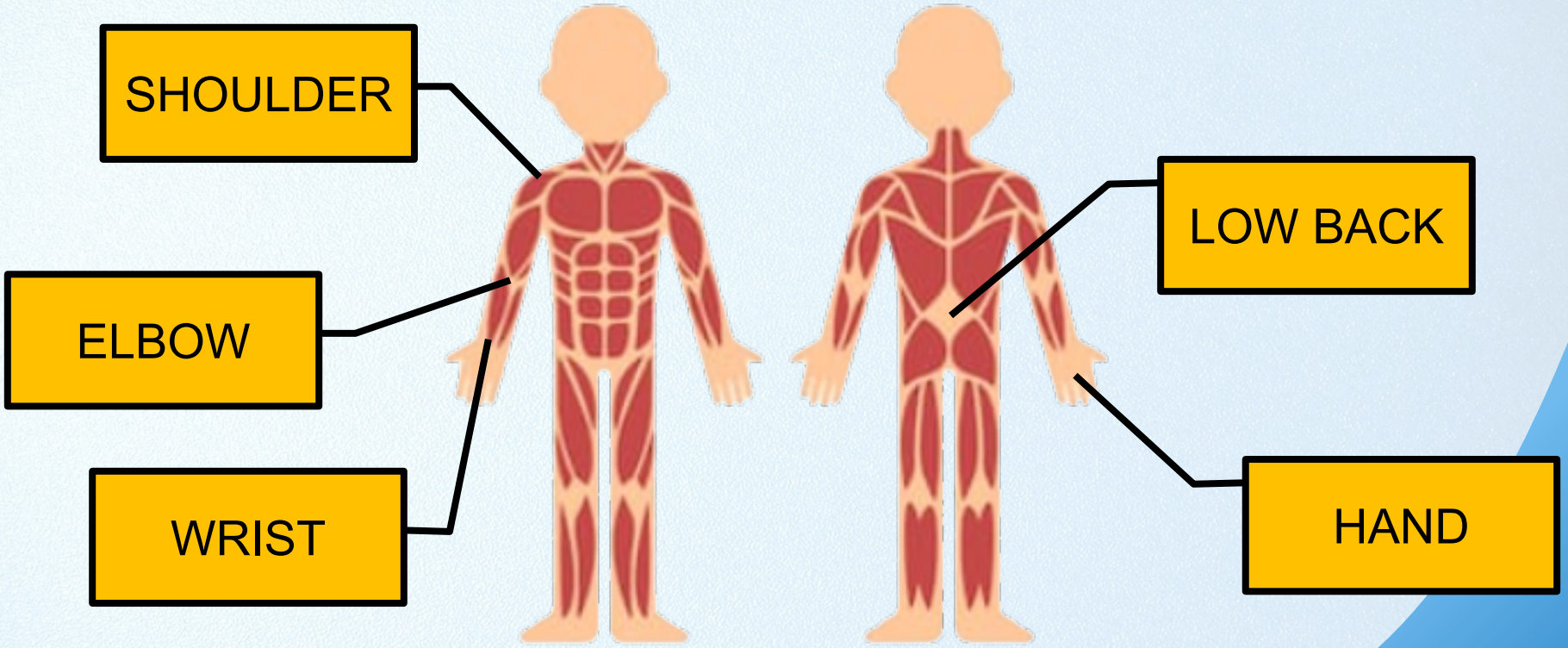
2

3

4

BONUS – Hot cells at TA 48 and 53!

High risk for GB ergo injuries (Top 5)



Shoulder and Elbow: $$$

- **Highest severity –** Surgery and career ending
- **Highest frequency –** (Since 2010-2020) - **8 shoulders & 14 elbows**
- **Most costly :**
  - Shoulder surgery direct + indirect cost: ~$120,000 to $200,000
  - Elbow surgery direct + indirect cost: ~$100,000

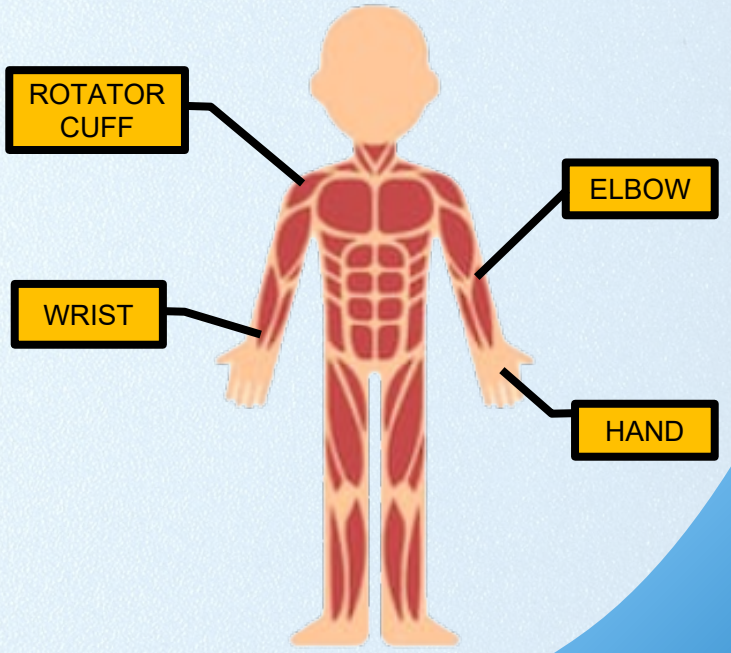
Common Ergo Injuries for GB Workers

1. Rotator Cuff - supraspinatus
   Abnormal ratio of external vs. internal rotators

2. Elbow – lateral epicondylitis

1. Wrist – carpal tunnel

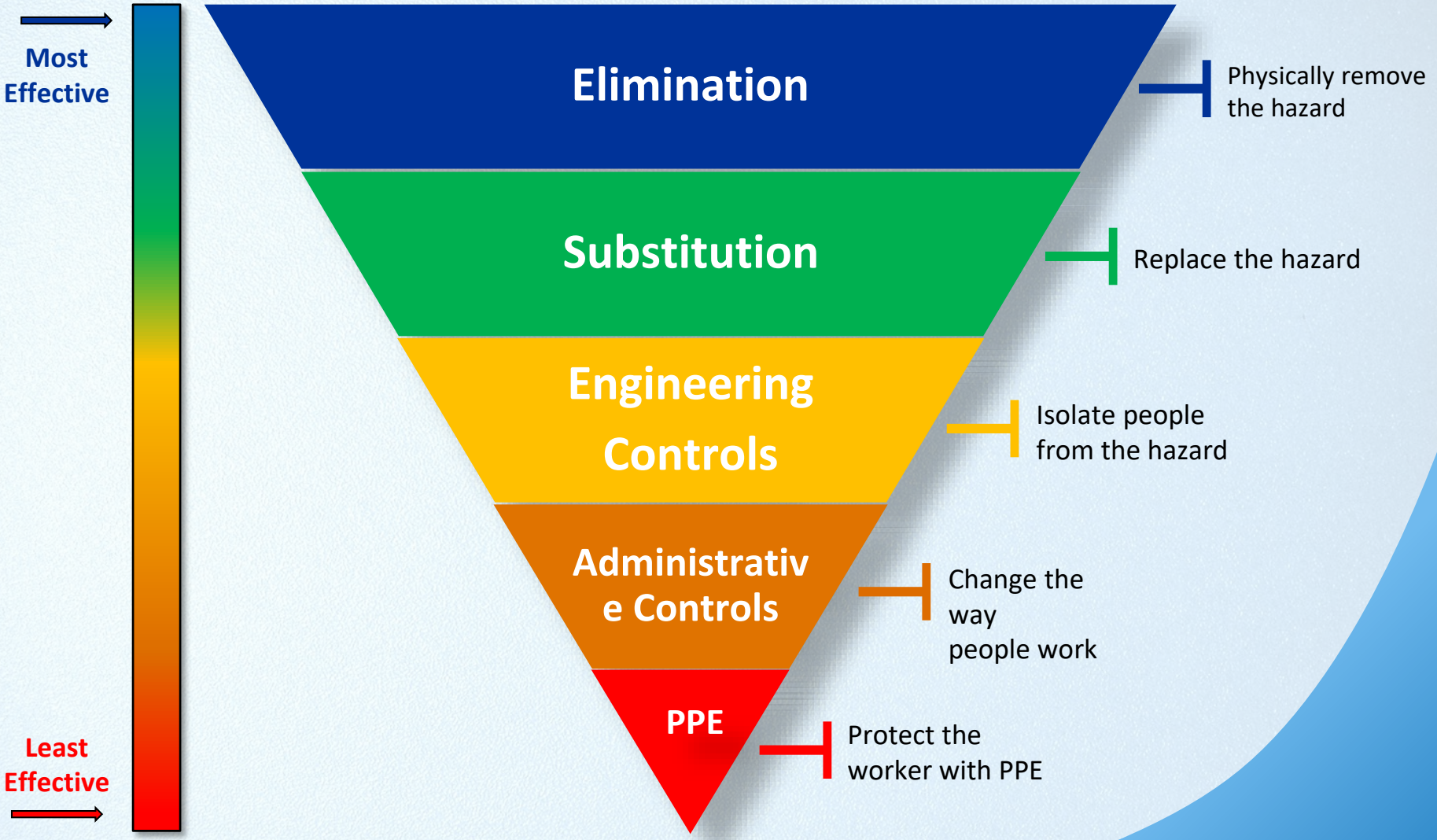
1. Hand – Thumb issues



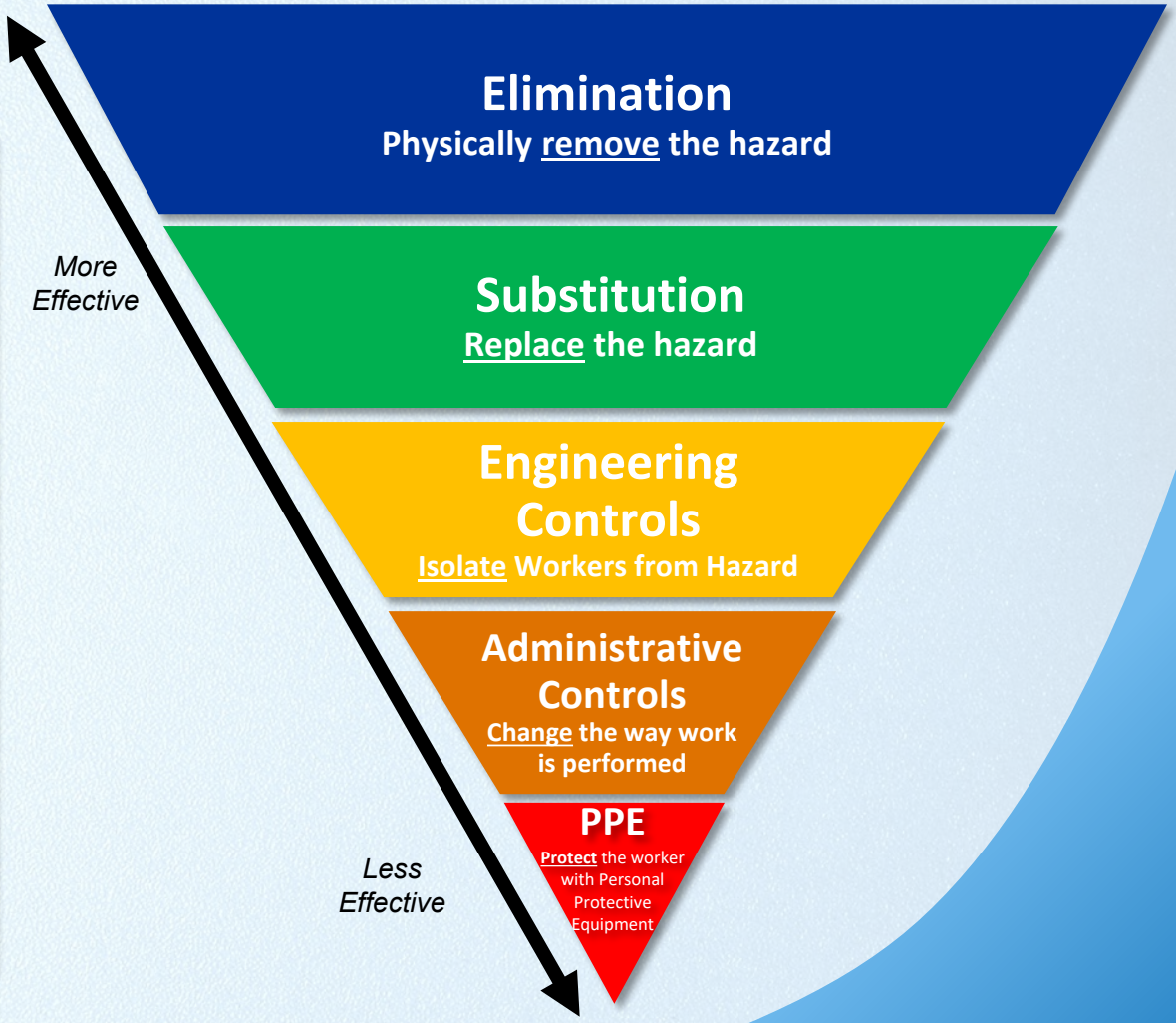
Glovebox Activities With High Risk

- *Bagging out waste*
- *Rolling drums over floor obstacles*
- *Lifting lids that don't have handles*
- *Moving objects in and out of the tunnels or wells*

NIOSH Hierarchy of Controls



Hierarchy of Controls Exercise



Time for a Short Break!

Ergo Hazards

- *Repetition* 
- *Duration* 
- *Posture* 
- *Force* 
- *Vibration* 
- *Environment* 
- *Individual Physiological and Psychological Factors* 

Ergo Controls for Workers – Repetition

Repetition is the number of times a particular movement is repeated over a period of time. An example of repetition for glovebox workers is the number of times per minute a worker installs screws in an object.

You can minimize repetition by taking microbreaks—small, 30-second breaks in which the affected muscles are relaxed or stretched. If you and your coworkers perform highly repetitive tasks, you can rotate these tasks among each other. Training more than one worker to perform the same tasks allows rotation of the tasks amongst the employees.

Broadening the scope of a worker's job to include other duties that do not involve the same motions also reduces the risk while increasing morale and job interest. Rotation of tasks reduces risk as long as the tasks use different muscle groups.

Ergo Controls for Workers – Duration

Duration is the amount of time during which the same movement or sequence of movements is performed without a break. An example for glovebox workers is the amount of time a workers spends performing work in a glovebox in any one day.

You can control duration by taking appropriately timed breaks. Shorter, frequent breaks are more effective than longer breaks taken every 30 minutes for 2-5 minutes. Breaks can either be personal breaks or “work” breaks—periods in which you perform one or more tasks that require using a different group of muscles.

Ergo Controls for Workers – Posture

Posture is the positioning of the various parts of your body as you perform work. Every joint has a “neutral” position which muscles and tendons work most efficiently, leading to less fatigue and mitigating risk of injury. Generally, an “ideal” posture incorporates the back in the natural **S-shaped** curve with arms below shoulder level and wrists in the neutral position.

The goal is to set up your work to allow your body to perform tasks close to the neutral position. This is not always possible. It is important to recognize if you are assuming awkward postures and take appropriate actions to avoid them or break on a more frequent basis.

If you maintain a prolonged awkward posture, you increase your risk of developing an ergonomic injury. In addition, periodically changing positions prevents the application of pressure to one area of your body

Ergo Controls for Workers – Force

Force is the amount of energy that is applied by you or to you.

- Examples of force applied by you are gripping a tool and striking an object with a tool.
- Example of force applied to you is the force applied to your forearm when you lean it against the edge of the glovebox glove port.
- Either type of force can compress tendons, nerves, or blood vessels. When you needlessly apply too much force, you increase your risk of getting an MSD.

Ergo Controls for Workers – Force (cont.)

1. **Reduce the Force Applied <u>BY</u> You**

- Reduce the force you exert when striking or holding and moving objects. You are required to wear at least anti-C gloves when working in a glovebox, which means you have two pairs of gloves on at any one time. Your grip strength can be reduced when wearing certain types of gloves. Therefore, you may need to apply more force when wearing such gloves, which increases the risk factor of force.
- Keep commonly used heavy objects closer to where you normally access and work at the glovebox. This reduces the amount of force you must apply to grasp and hold such objects at a distance. You may have to reorganize the inside of your glovebox.
- Perform tasks in a neutral position
- Use tools with larger handles
- Use correct tool for the job
- Get help for heavy, bulky or awkward movements or items.

2. **Reducing the Force Applied <u>TO</u> You**

- Try not to continually rest your forearms on the glove ports.

Ergo Controls for Workers – Lifting

If you do not normally lift heavy objects in a glovebox or have not lifted in a while, consider asking for help. Utilize assistance or an assistive device if the weight to be moved in a glovebox is greater than 15 lbs.

If you do decide to lift, before doing so, consider the following:

- how far the object must be moved within the glovebox and glovebox line,
- what barriers or obstructions in the glovebox may be in the path, and…
- whether sufficient lighting exists along the entire path.

Ask for help from co-workers to reduce the effort and strain.

Ergo Controls for Workers – Vibration

Vibration from tools and machinery alone or combined with other ergonomic risk factors can cause serious long-term health effects. If your job exposes you to extended periods

of time working with vibrating tools or machinery, consider using the following controls:

- Select tools and machinery with low vibration emissions and ensure that they are well maintained to avoid excessive vibration.
- Isolate vibrating sources or surfaces of machinery with shocks or springs. Shocks and springs can reduce equipment vibration.
- Reduce the time you are exposed to vibrating sources.
- Reduce your use of vibrating tools or operate them at the lowest speed you can without increasing the time needed to perform the task.
- Wear anti-vibration gloves to reduce vibration transmitted through your hands. Use of toolwrap allows customization of handle size as well as providing vibration reduction.

Ergo Controls for Workers – Environment

Environmental conditions may also affect your risk of developing ergonomic injuries.

Some environmental conditions, once identified, are easy to control, but others are more difficult.

Environmental factors that may affect the risk of developing ergonomic injuries include lighting, noise, and temperature.

Ergo Controls for Workers – Individual Susceptibility

Individual susceptibility to ergonomic injuries is influenced by those physical and mental factors that are unique to every person, including genetics, medical conditions, fatigue, stress, and lifestyle.

Personal health including proper nutrition and regular exercise programs reduce the risk of an ergonomic injury.

Design with anthropometrics in mind would help control individual susceptibility.

Hand Position

Thumb up!

or

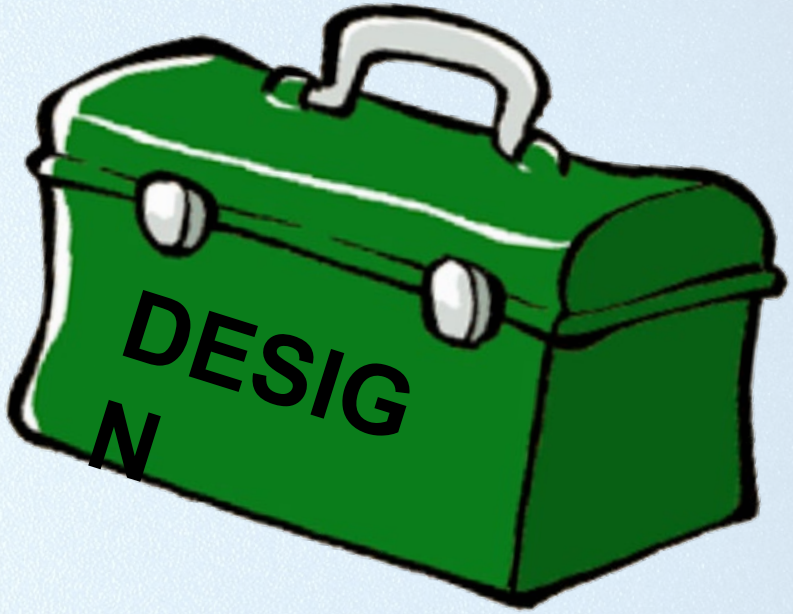
Palm up!

GB Ergo Design Guidance

1) *Depth and width of box*
2) *Gloveport placement*
3) *Illumination*
4) *Windows*

Ergonomics Design Toolbox

- Anthropometry
- Ergonomic Guidelines
  - ACGIH
  - RULA
  - Many more
- Computer Simulation
- ***INVOLVE THE OPERATORS!***

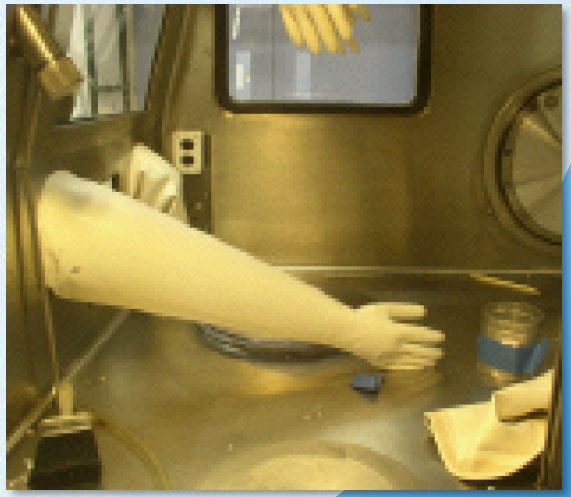


Depth and Width

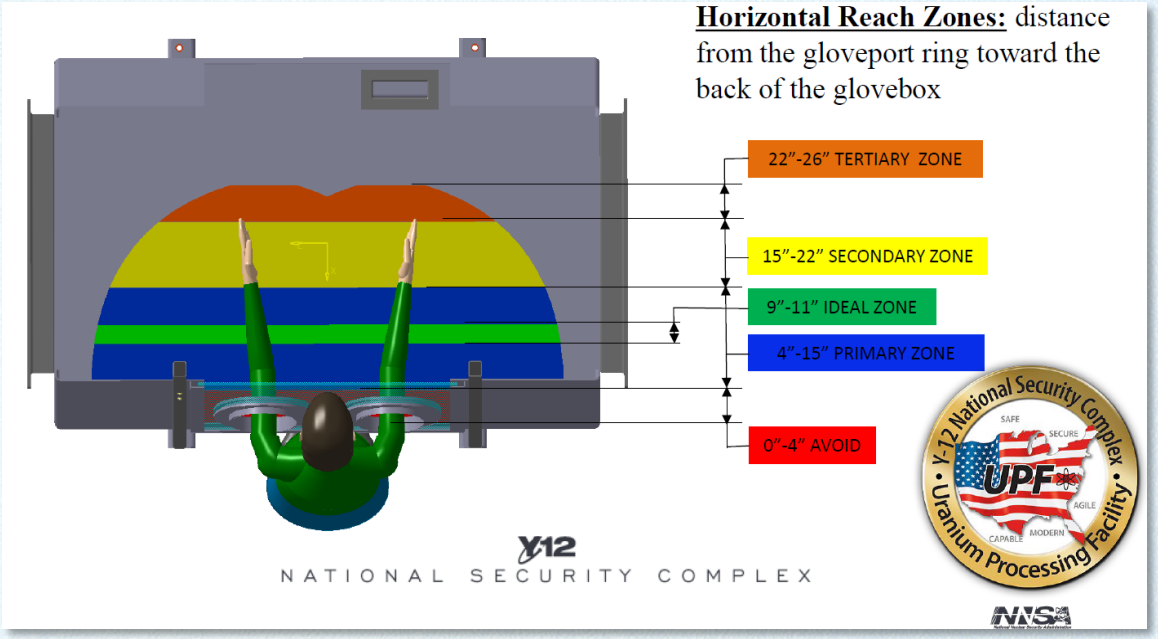
Glovebox overall depth dimensions:

- Single-sided access 24 to 26 inches
- Double-sided access 48 to 52 inches

- Over-lengthening of midback
- Stress on shoulder and neck



Functional Work Space



- Directly in front of Gloveport
- Very Important with entry or bag out ports

Ideal Work Envelopes

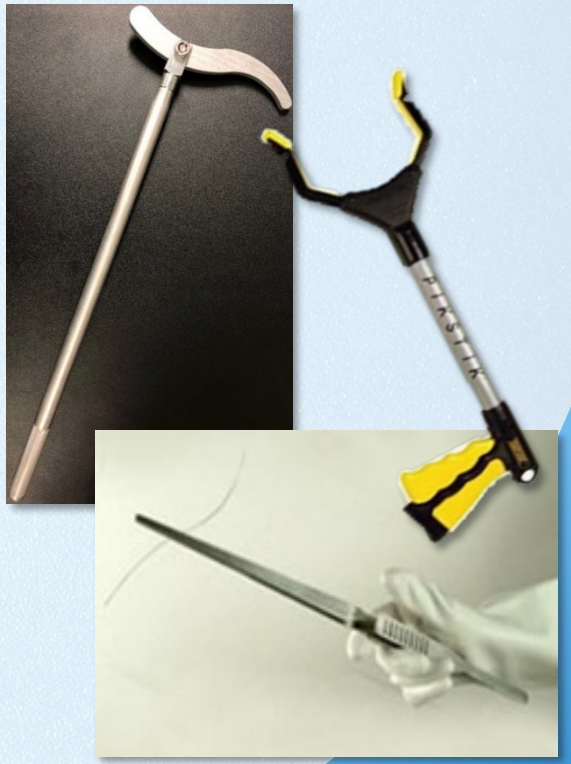
- **Perform majority of tasks:**
  - Primary work envelope - 9 to 11 inches (frequent tasks)
  - Secondary work envelope - 15 to 22 inches (1-2/day)
  - Tertiary work envelope – 22-26 inches (≤1/wk)

- **Ideal working position dependent on tasks:**
  - Precision tasks
  - Gross motor skill tasks

Recommend mini-breaks every 20-30 minutes

Reach Distance

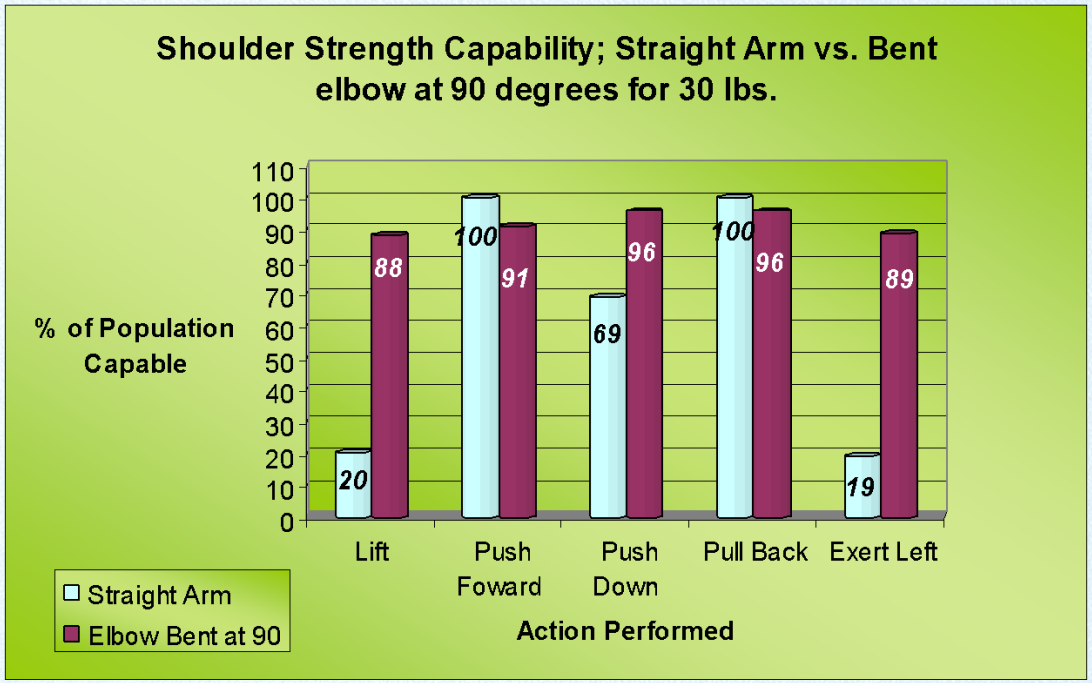
- Using tools for reaching (left) helps you to maintain your body in a more neutral posture.



Lifting

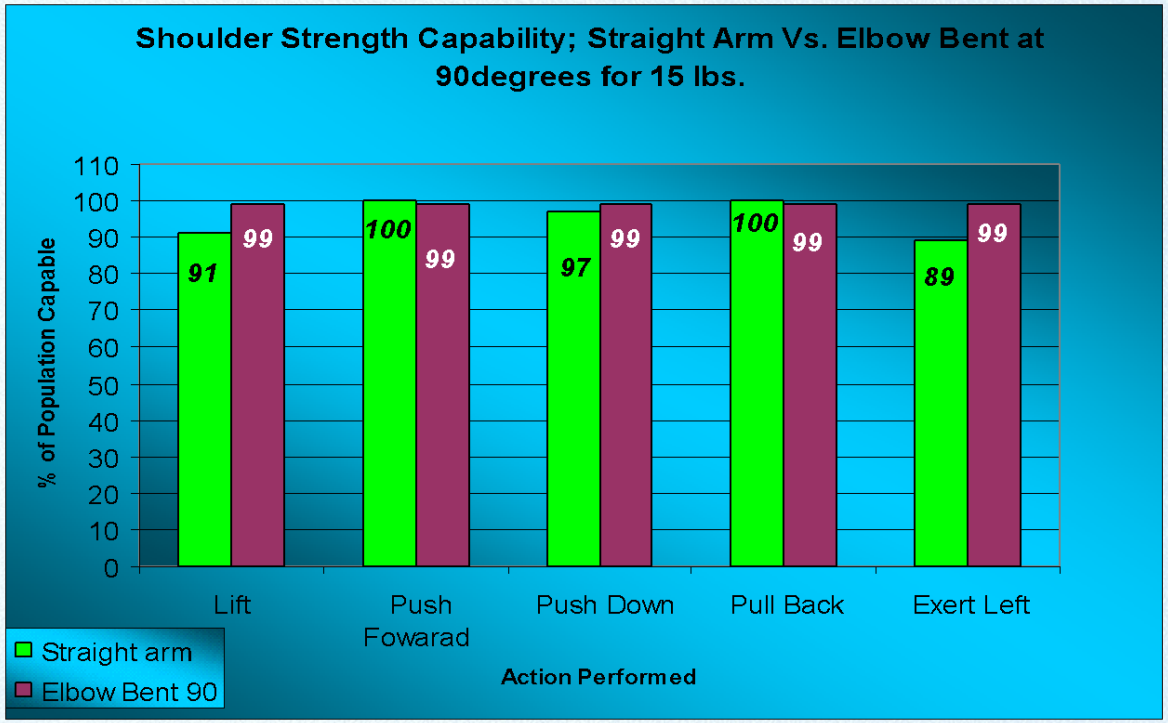
- When lifting within a glovebox through gloveports, the weight of 15 lbs. should not be exceeded
- For greater than 15 lbs., the task should be analyzed to determine best lifting assists

Shoulder Strength for 30 lbs.



- Straight arm decreases significantly
- Bent elbow- also decreases
- Notice that exertion to the left and lift have the lowest percent of the population capable

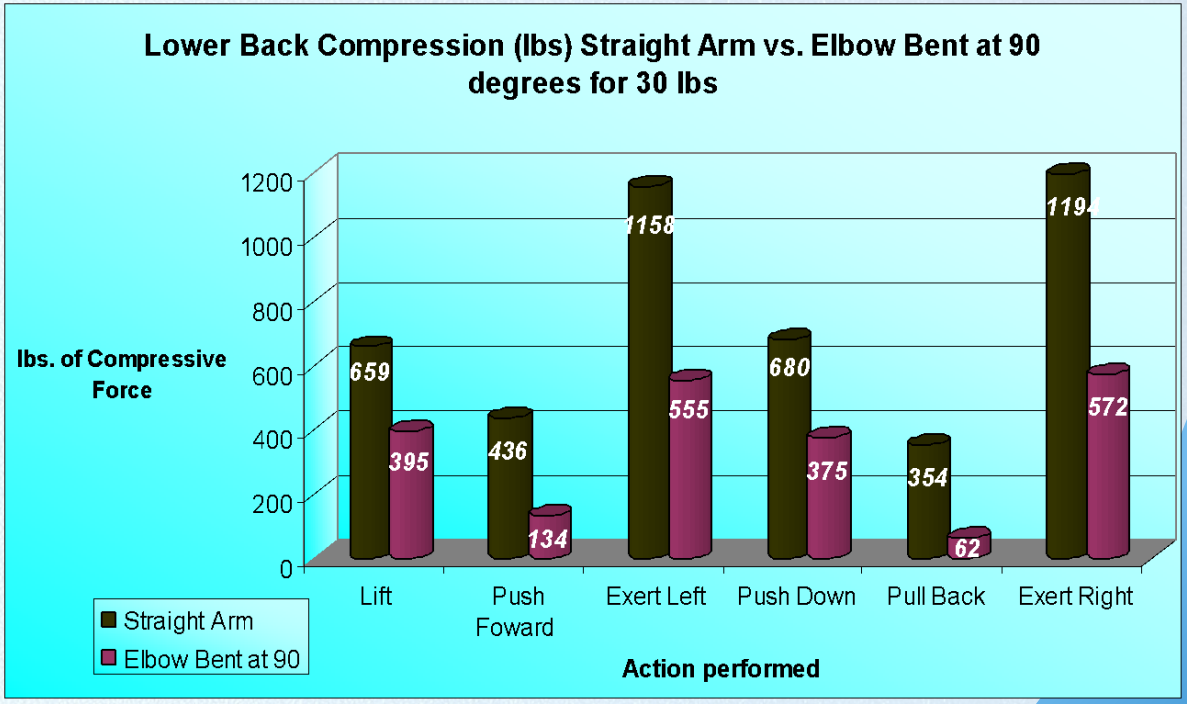
Shoulder Strength for 15 lbs.



- 15 lbs. seems to be a reasonable weight

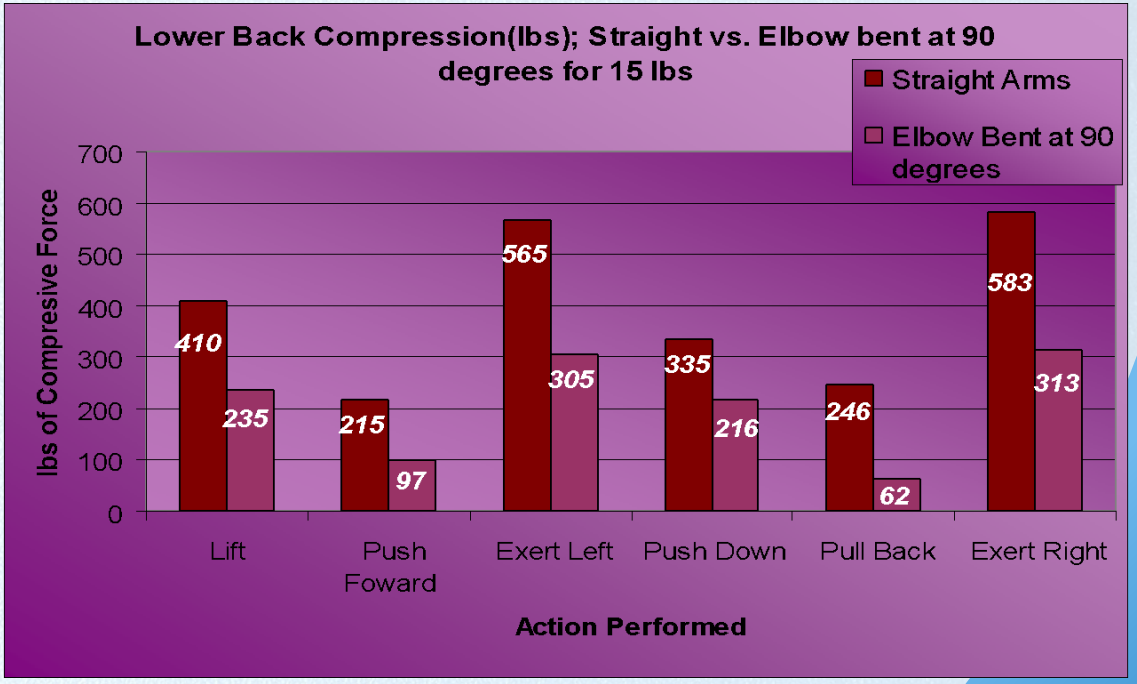
Lower Back Compression for 30 lbs.

- Great difference in the Straight Arm
- Only minimal difference in Bent Elbow
- Exertion to the Left and Right almost double

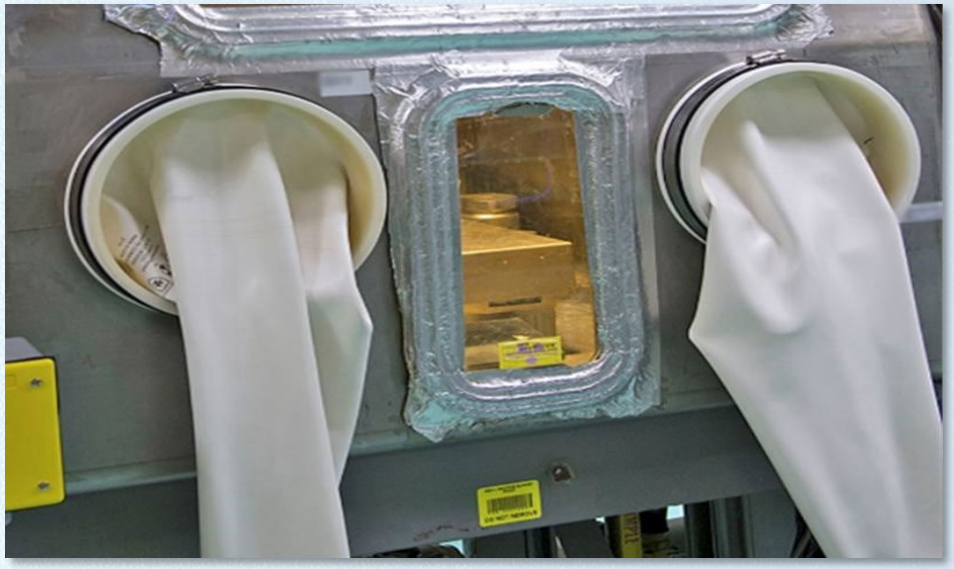


Lower Back Compression for 15 lbs.

- Low compressive force on the lower back
- Extreme difference between Straight Arm and Bent Elbow
- Exertion to the Right and Left highest

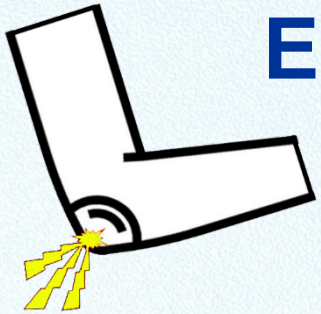


Gloveports

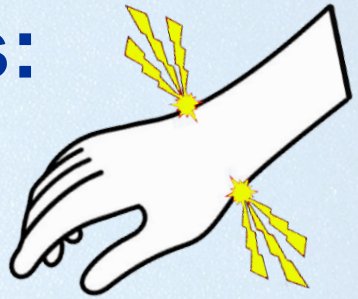


- Design gloveports to facilitate replacement of gloves without breaching containment

- Oval-shaped or large-diameter rings
  - increased functional reach capability
  - accommodate a greater range of heights



Elbow and Wrist Injuries:



Relationship between

GLOVEPORT HEIGHT

and

FLOOR OF THE BOX

Height of Box / Cleaning Up

Wrists in awkward positions

Wrist Injuries

Gloveport Height

Problem?

- Glovebox ports too high
- Neck extension can cause headaches, and neck tension
- Shoulder 70-110

Solution?

- Portable platform allows for a neutral posture

Note the stance in this photo.

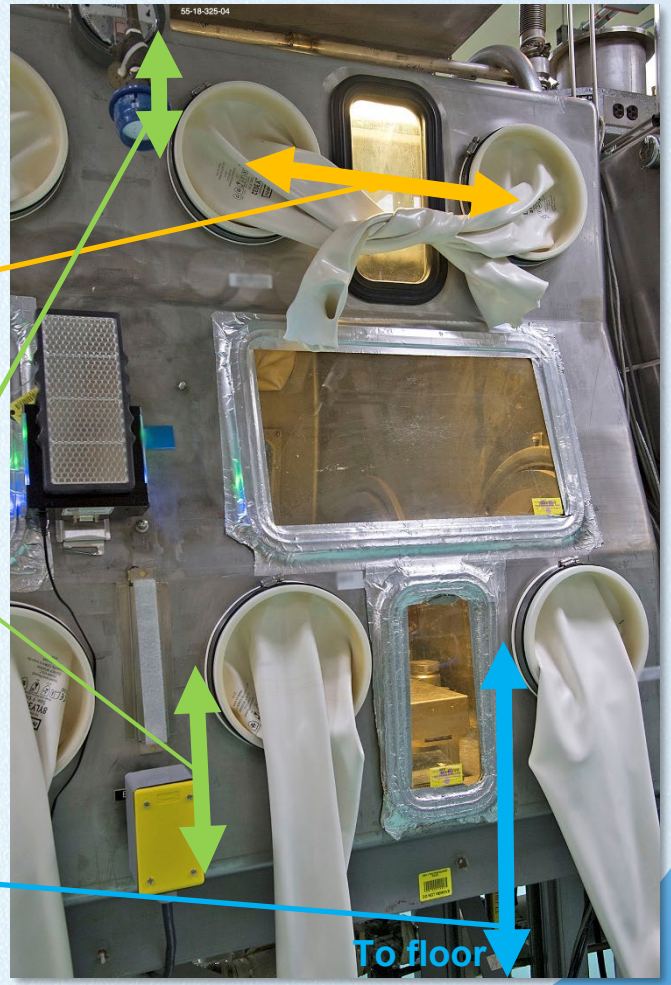
One foot is in front of the other and the knees are slightly bent, permitting a more neutral spine position.

Gloveports Placement

1) Spacing between gloveport centerlines:
   - nominal 16.5 inches (range from 15 to 18 inches)

2) For reach access, horizontal centerline of glovebox top/bottom should be a maximum of 18 inches

1) Centerline height for standing workers
   - normally be 48 inches (range from 48-52 inches) from finish floor
   - multi-adjustable footstools to accommodate range of workers



Illumination

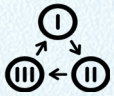
- Dimmable lighting both inside and outside the glovebox to minimize glare
  - 30 to 100 foot-candles at the w urface
- Provide luminaries with baffles to ht, and ensure light tube is not directly visible to the eye
- Make sure interior equipment d es n ck light source
- Chose interior finishes that m imizes glare

Windows

- Select material based on: transparency, resistance to fire, abrasion, corrosion, and breakage
- Maximize size to optimize visibility
- Placement best at eye level and centered above pair of gloveports
- A sloping glovebox face:
  - 10° minimum to 15°maximum
  - reduce glare and potential blind spots
  - enhance vision and working posture

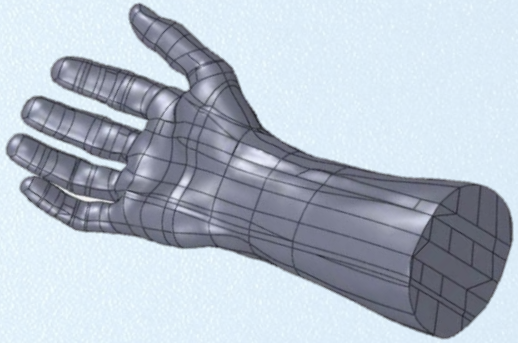
Time for a Short Break!

Other GB Features / Activities to Consider…

1. *Gloves* 
2. *Tooling* 
3. *Maintenance Activities* 
4. *Controls and Displays* 
5. *Procedures* 

Gloves

- Thick or inflexible gloves
  - tasks should require only crude manipulations



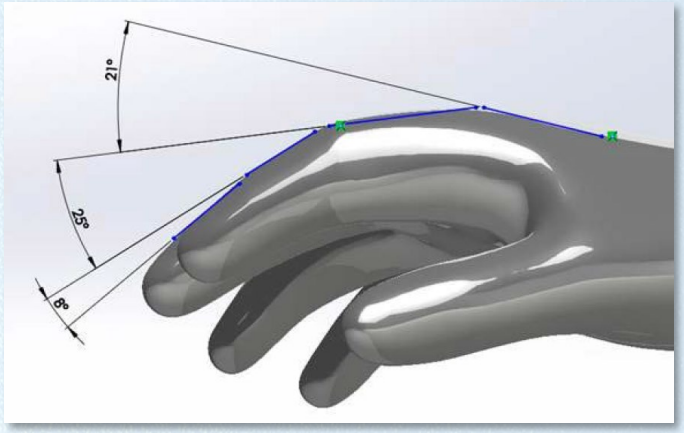
- Use gloves with a “grasp” design
  - decrease muscular fatigue
- Improve contact friction with textured finger surfaces
- Consider ambidextrous gloves near entry ports

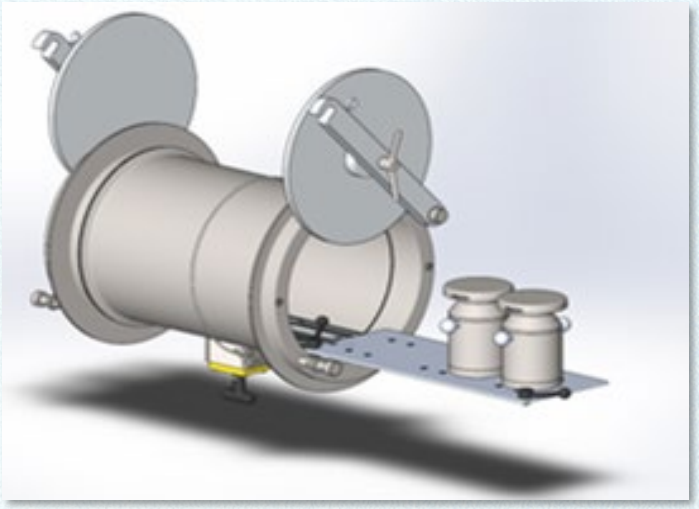
Ergonomics – Help Avoid Glove Breaches

- Crease
- Wear
- Breach
- Poor Ergonomics
- Injury Risk

Solutions

New glovebox glove mold





Retractable shelf
for airlock

Push/Pull
Reach Tool

New Tools for GB work

- Make work easier
- Less force
- Reduce ALARA
- Mitigate risk of Injuries
- Always work with operators!

Maintenance Activities

- Color-code and/or label valve handles, process lines, and utilities, for quick identification
- Label and identify gloveboxes, gloveports, etc.
- For easy cleaning and decontamination:
  - Interior surfaces materials and surface finishes should be smooth
  - All of the interior equipment and surfaces should be accessible from gloveports
  - Round interior corner radii
  - If gaps or crevices are present, they should be filled with suitable non-porous material

Controls and Displays

- Provide simplistic info/labels for quick identification and interpretation of any controls and displays
- Provide adequate spacing for glove-hand and finger clearance
- The preferred location is eye level
- Linear numerical scales on gauges and dials to minimize reading errors
- Enlarged gauges for improved readability

Auditory Memory – Procedures

Now, let's test your auditory memory.

I will read out a series of 15 objects.

Do not write them down, but listen and try to remember them.

Next, using a pen and paper, write down as many words as you can remember in 30 seconds.

How many did you get right?

Penguin

Bucket

Microwave

Cat

Rattle

Balloon

Telephone

String

Iron

Picture Frame

Kangaroo

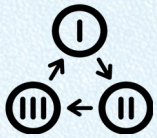
Sequin

Crayon

Trousers

Bicycle

Procedures



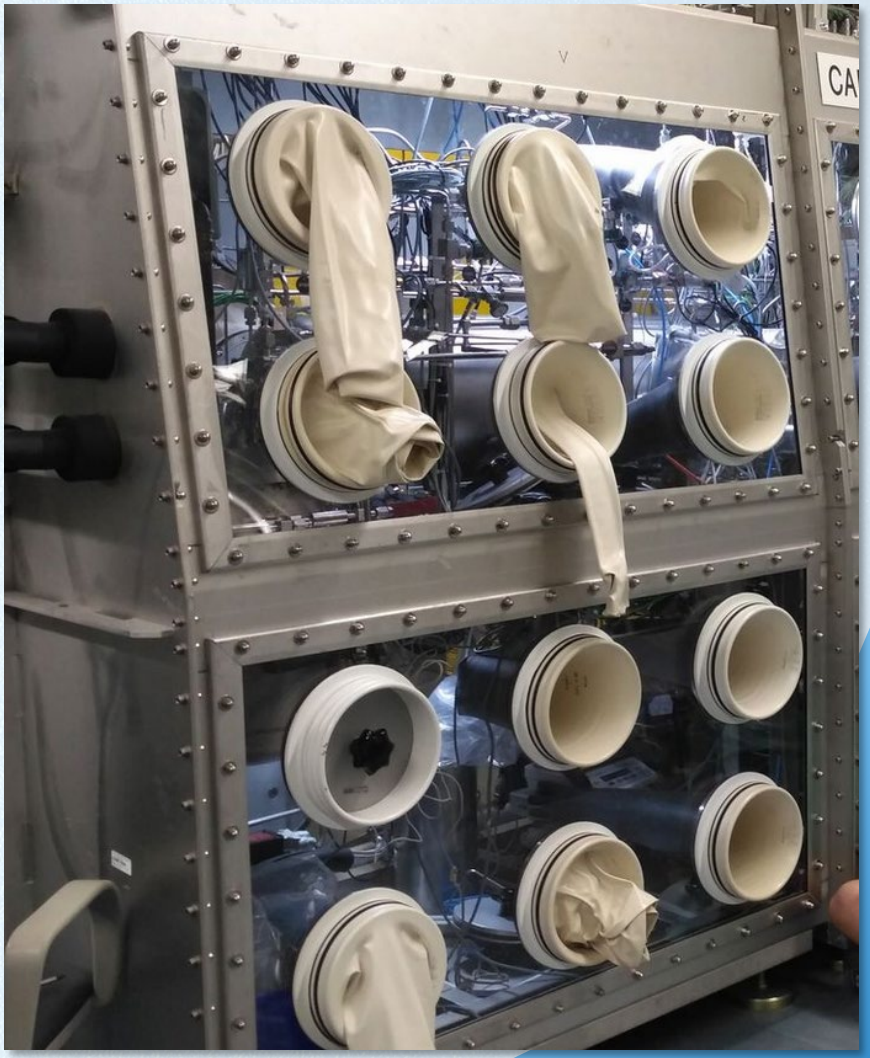
- **For Reader-Worker** procedures, keep individual directions short and succinct
- If physical layout of process is confusing, include a drawing
- Provide stands in convenient locations for any procedures, limits, and notes to encourage and facilitate their usage (e.g., music stand, clips on glovebox face between windows)

Time for a Short Break!

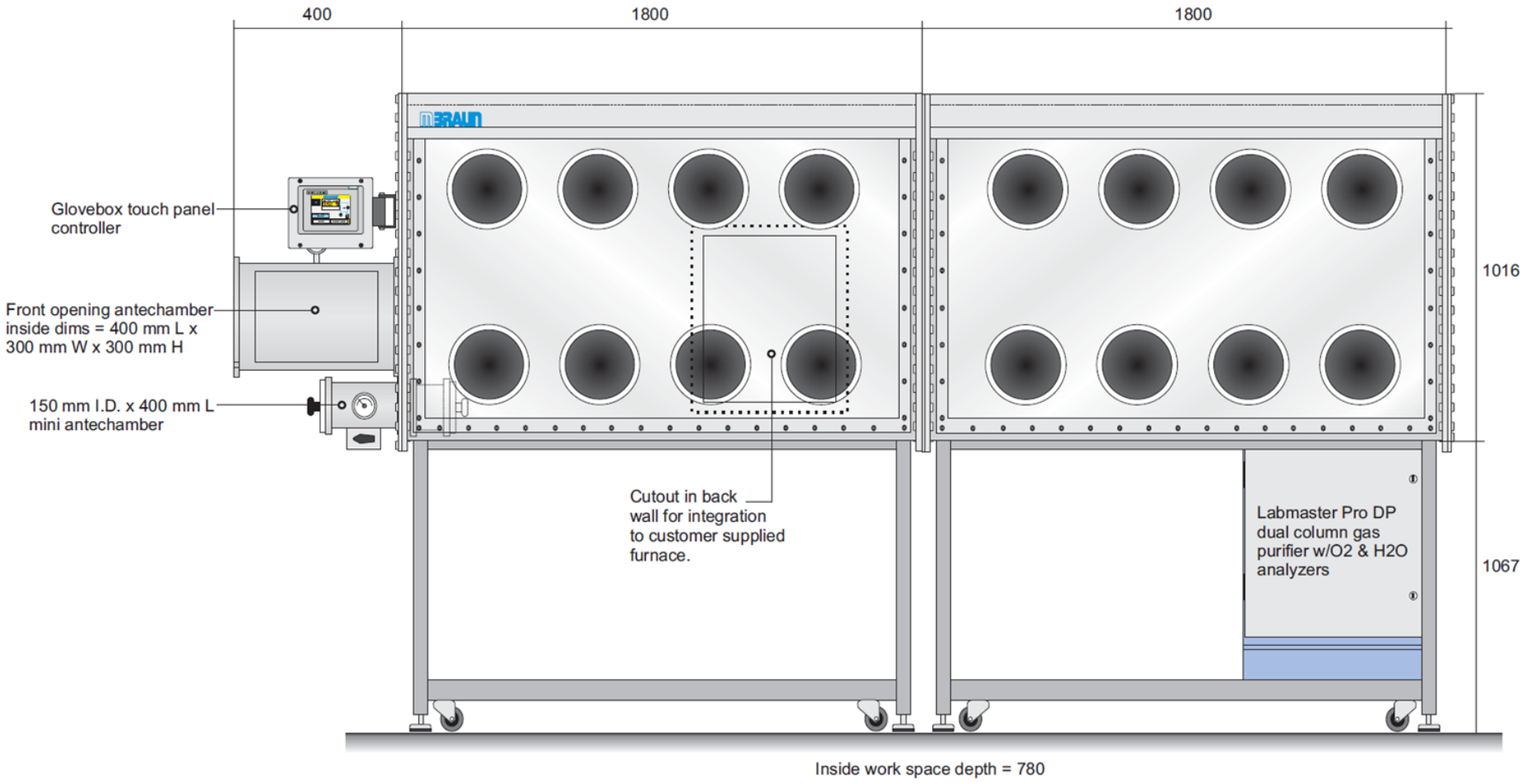
Scenario 1 – Proactive GB Activity Eval

- Change out or maintain all valves and valve tags in the facility
- Regular maintenance activity every 5 years

Proactive management ergo request



Scenario 2 – GB Design Eval



Drawing File Name: LANL Glovebox Concept Sketch

When would you get to evaluate a GB?

Design / Retrofit

- Ergo is part of 410 purchasing approval process

Readiness (mainly TA 55)

Operator/Manager originated

- proactive or reactive

Common GB Worker Stretches: Forearm Stretches

- Maintains normal muscle length

Rhomboid Strengthening

- Strengthens the upper back

Rhomboid Strengthening

- Upper rhomboid strengthening

Rotator Cuff Strengthening

External rotation

Rotator Cuff Strengthening

- These exercises can also be performed with a portable stretch band

Internal rotation

The Traffic Cop Exercise

- Promotes normal neck muscle length, and helps reduce tightness

GB Ergo Resources

Meow Wolf in Santa Fe, NM

GB Ergo page:

https://int.lanl.gov/employees/health-wellness/ergonomics/glovebox-ergonomics.shtml

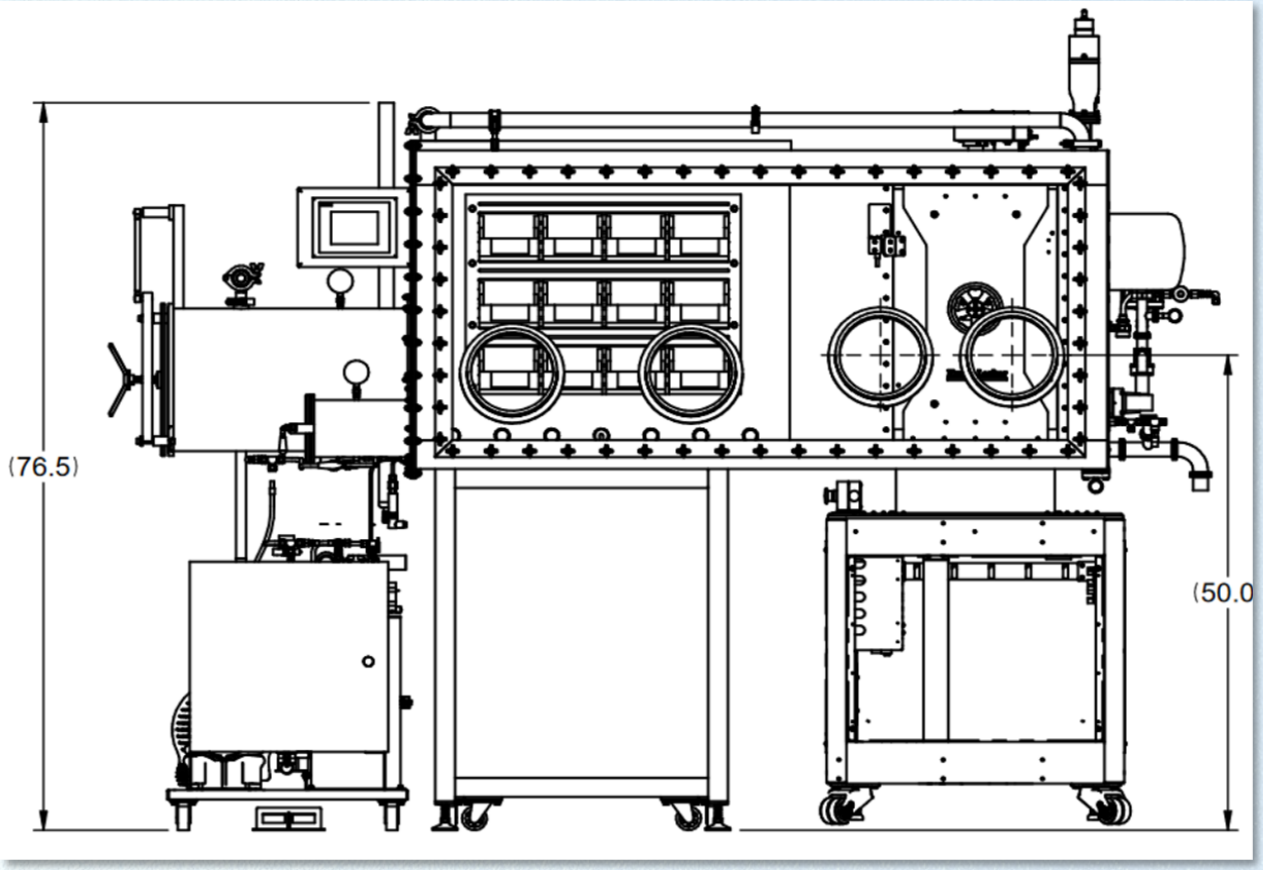
GB worker stretches video:

https://int.lanl.gov/computing/communications/video-streaming/viewit/vod/browse-videos/glovebox-worker-stretches.shtml

Institutional GB Safety:

https://int.lanl.gov/safety/industrial_hygiene_and_safety/ihs_programs/glovebox.shtml

Homework?!



Drawing File: mini with 4 port GB General Assembly Quote File: LANL_Mini_SQ_212208db7 mini for Be-1

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Questions?

Glovebox Ergonomics Basics for Ergonomists Course #50606

https:://www.surveymonkey.com/r/Student_Feedback_LANL_HR-ITS

Email contact:
Ta55ergo@lanl.gov
or
ergo@lanl.gov

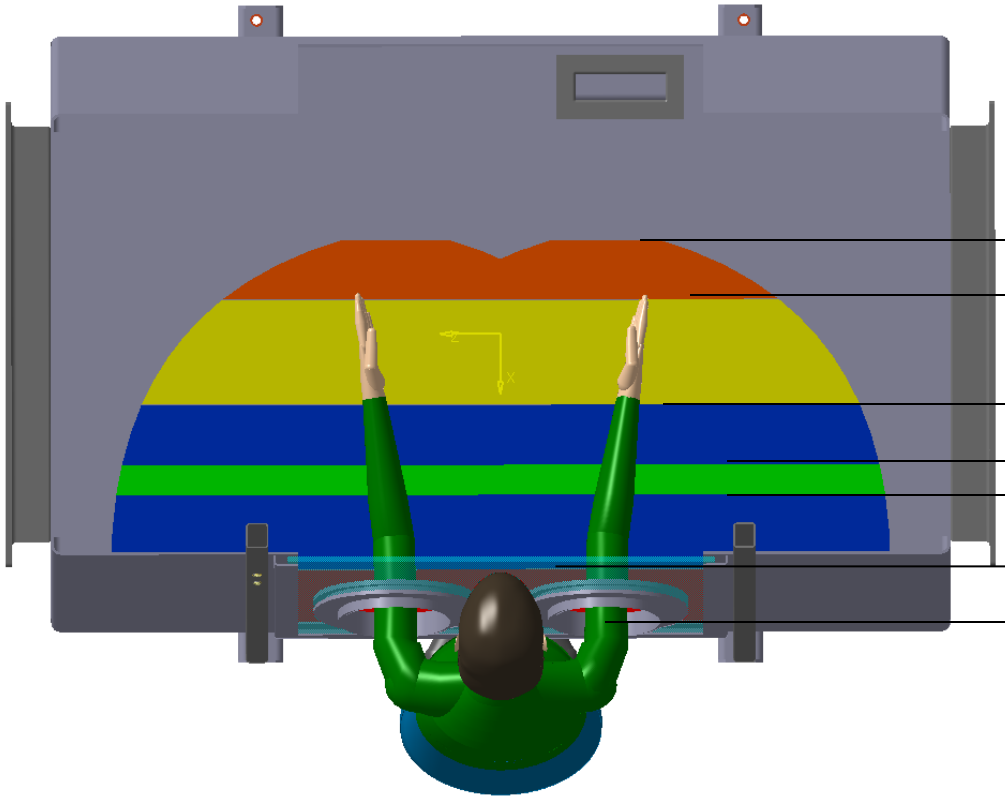
ERGONOMIC REACH GLOVEBOX RECOMMENDATIONS

Definitions:

Weight limits: 7 lbs single handed; 15 lbs two handed.

- Primary Zone: Frequent tasks; performed routinely throughout the day. Recommend mini-breaks every 20 – 30 minutes
- Secondary Zone: Less Frequent tasks : 1 – 2 times per day
- Tertiary Zone: Infrequent tasks: no more than once a week

Horizontal Reach Zones: distance from the gloveport ring toward the back of the glovebox



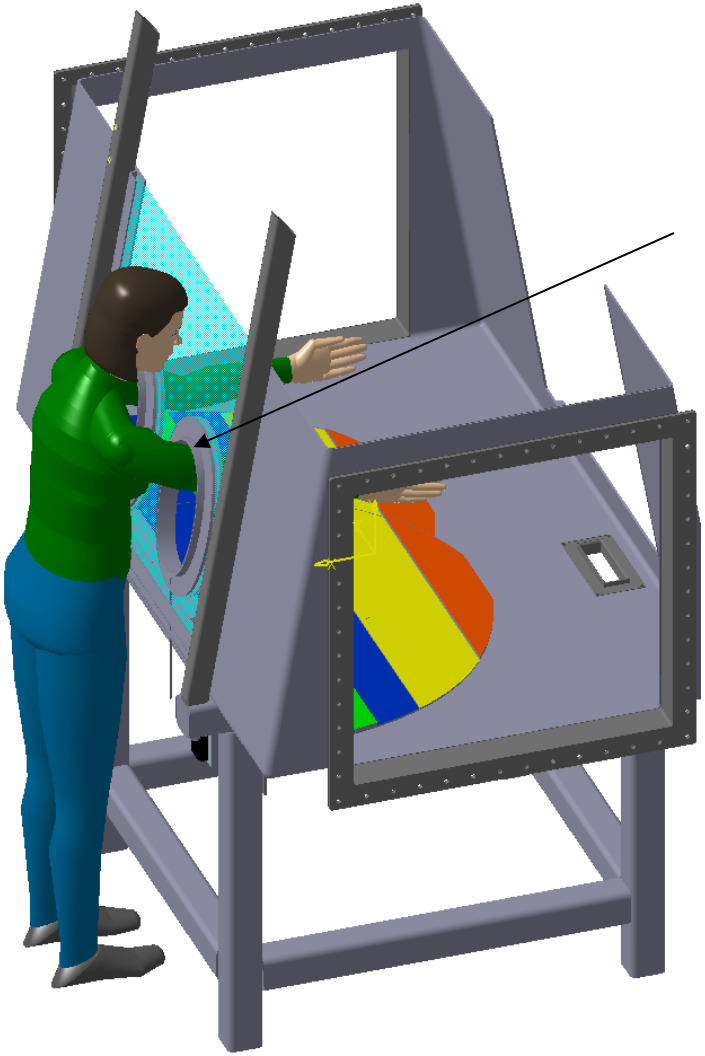
22”-26” TERTIARY ZONE

15”-22” SECONDARY ZONE

9”-11” IDEAL ZONE

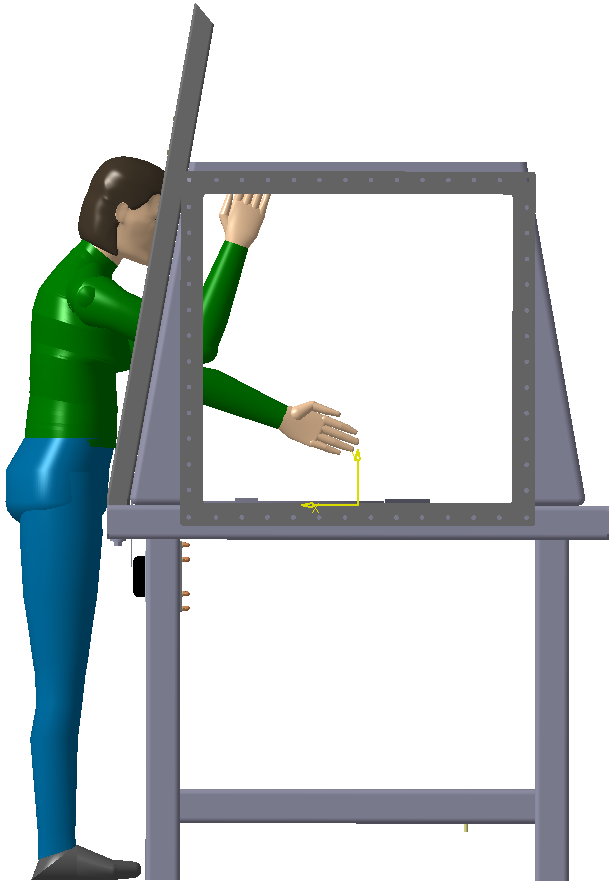
4”-15” PRIMARY ZONE

0”-4” AVOID



<u>Vertical Reach:</u> Distance from the gloveport ring apex (top) toward the ceiling.

- Primary Zone: Within 6 in
- Secondary Zone: 6 – 9 in
- Tertiary Zone: Infrequent tasks: 9 – 12 in
- Avoid: Vertical Reaches > 12 in.



Glovebox Design Checklist
GB# Quote:
Reviewer (Name, Z#, Group): Date:

Summary:

General	
# of workers trained for this task:	Task rotation planned: Y / N
Avg # of hrs per day in GB:	Avg # of days per week in GB:
Avg time btw break:	Longest duration in GB:
Comments:	

	NI	S	N/A
Maximized Process Flow – min material move across a double wide GB			
Comments:			
Ease of performing work tasks			
• work tasks meet horizontal (4"- 22") and vertical (< 9 ") guidelines			
• floor area between gloveports is clear			
• Prep space and storage appropriate			
• Space in front of airlocks is clear			
• GB floor clear path to allow ease of sliding of materials between ports			
Comments:			
Weight guideline (see weights per reach zones)			
• items weigh < 15 lbs			
• Most lifts can be performed 2 handed			
Comments:			
Lighting/Viewing			
• Window design allows maximum viewing Full visibility if possible; otherwise Diamond.			
• If full visibility window; orientation to room lighting is appropriate			
Comments:			
Grasping			
• Repetition of small grasping < 1x/10 min in primary reach zone (4 – 15 in)			
• Tool or handle diameters >.5 in. and round			
• Tool weights ≤ 2 lbs			
Comments:			
Weighing – balances easy to read and use			
Comments:			

NI – Needs Improvement S – Satisfactory N/A - Not applicable

Utilities – electric outlets can be easily reached			
Comments:			
Maintenance			
• all activities reviewed for efficiency and weight limit of < 15 lbs			
• color code wiring			
• Maximized items outside of GB (motors/liquids plumbed in, etc)			
Comments:			
Outside glovebox			
• Top GB: ease for maintenance			
• No knee knockers (comment 1)			
• No items person would lean into			
• Viewing of gauges is maximized			
• Control panels reviewed for knobs size/type/spacing/viewing/reach			
Comments:			

Additional comments: NA